

# The influence of chronic social confrontation on oxygen consumption of *Tupaia belangeri* under resting conditions

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Under chronic social confrontation submissive and subdominant male tupaia show a pronounced loss of body weight when compared to dominant counterparts. In addition their heart rate frequencies increase and they lose their circadian pattern in heart rate (v. HOLST et al. 1983). The results indicate an elevation of the basal metabolism of the loser in these physiobehaviorally definable situations. To get a better understanding of the physiological processes under social confrontation in winners and losers we measured the oxygen consumption in the resting period (dark phase) of dominant as well as subdominant/submissive animals since oxygen consumption is a good and reliable index of the intensity of metabolism. In comparison to telemetric measurements of heart rate or body temperature this approach has the advantage that oxygen consumption can be recorded easily and without stressing the animal by carrying the transmitters or provoking repulsions of transmitters in consequence of immunoreactions in losers.

For the present experiments three adult male *Tupaia belangeri* from our breeding colony were kept under standardized conditions as previously described (see v. HOLST et al. 1983). Oxygen consumption was recorded during the resting period from 21.00 h to 9.00 h three times for each animal before and three to six times during confrontation by an openflow oxygen analysing system (Hartmann + Braun, Magnos LT). During the experiment the animals were kept in a plexiglas cuvette (20 × 20 × 14 cm) the flow rate was 43 l/h. All values are reduced to standard conditions (0 °C, 760 Torr). Body weight was recorded daily in the morning for each animal.

Under control situation (single housed) each animal showed its own characteristic O<sub>2</sub>-consumption profile during the resting period (Fig. 1). The curves are U-shaped. The drastic decrease in O<sub>2</sub>-consumption within the first hour in the cuvette is the result of a reduction of body temperature and heart rate (STÖHR, pers. comm.; STÖHR 1982) and a recovery of the handling stress. These results and the mean O<sub>2</sub>-consumption ± SEM of 1.22 ± 0.03 ml O<sub>2</sub>/g · h are in accordance with the data of WEIGOLD 1979.

Chronic social confrontation experiments were performed as described (v. HOLST et al. 1983). In two experiments (♂ 465 vs ♂ 471; ♂ 465 vs ♂ 448; lasting 8 days each) ♂ 465 was dominant; ♂ 471 and ♂ 448 were categorized as subdominant according to our former definition (v. HOLST et al. 1983). The results of these experiments (Fig. 2) indicate a different metabolic reaction which can be correlated with body weight. If there is no change in body weight (dominant and subdominant animals when coping takes place) O<sub>2</sub>-consumption is similar to controls over a long period of the resting time. The only difference lies in the morning hours, there is only a slight increase in metabolism. If the animals lose body weight a pronounced increase of the metabolic rate (mean ± SEM:

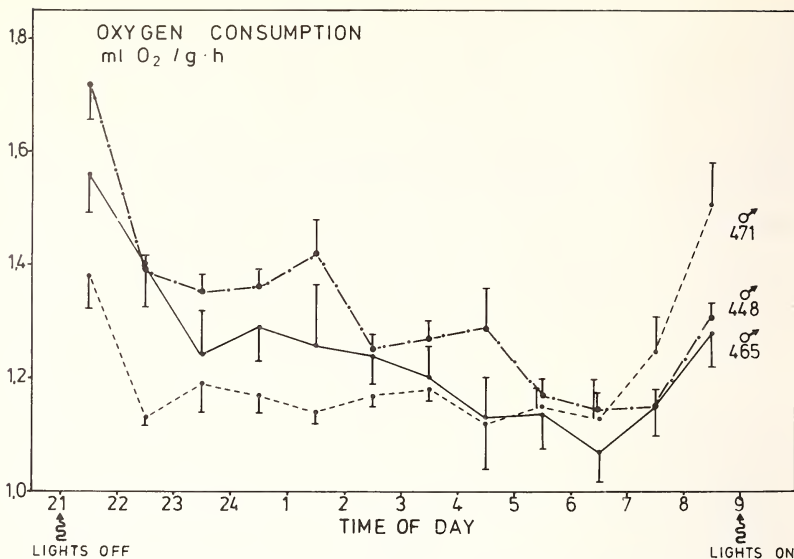


Fig. 1. Oxygen consumption during the resting period (21.00 h–9.00 h) of three single housed male tupaia. Shown are the mean oxygen consumptions per hour  $\pm$  SEM of three measurements per animal

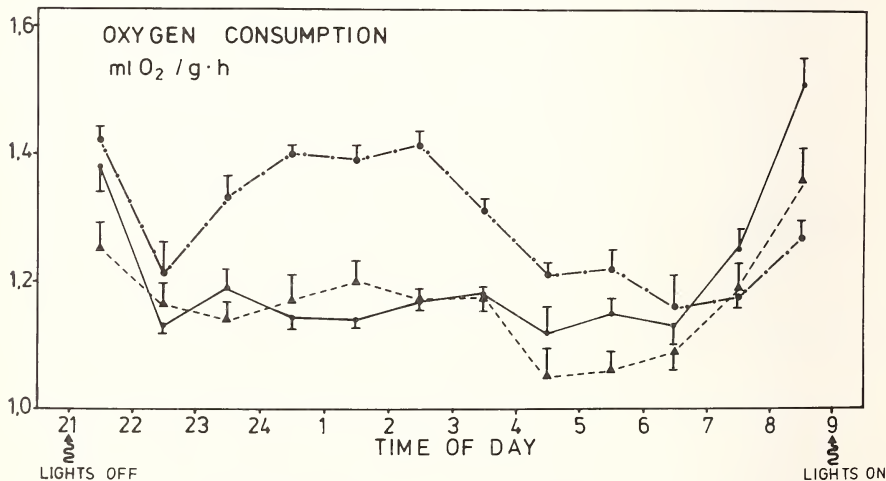


Fig. 2. Oxygen consumption during the resting period of three different states in male tupaia (I — single housed,  $n = 9$ ; II ---- social confrontation without loss of body weight,  $n = 9$ ; III - · - · - social confrontation with loss of body weight,  $n = 8$ ). Shown are the mean oxygen consumptions per hour  $\pm$  SEM. Analysis of variance revealed differences between situation III and the situations II and I;  $p \leq 0.02$

$1.31 \pm 0.05$  ml O<sub>2</sub>/g·h) can be observed. Interestingly the metabolic nadir about 7.00 hours has not disappeared but the metabolic drive to high levels like in control situation was almost abolished. This lack in increase from resting to active metabolic rates is in accordance with results on rank associated differences in metabolic rates in deer mice (FARR and ANDREWS 1978a). Higher values of O<sub>2</sub>-consumption in subdominants than in

dominants occur when deer mice are kept in high density populations (FARR and ANDREWS 1978b).

These results show that under chronic social confrontation the loss of body weight of tupaia is paralleled by an increase in metabolism during resting period. In addition, it seems that in the subordinate organism physiological mechanisms are activated to govern excessive energy loss by economizing metabolism in the second half of the resting period.

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#### References

- FARR, L.; ANDREWS, R. V. (1978a): Rank-associated differences in metabolic rates and locomotor activity of dominant and subordinate *Peromyscus maniculatus*. *Comp. Biochem. Physiol.* 61A, 401–406.
- ; — (1978b): Rank-associated desynchronization of metabolic and activity rhythms of *Peromyscus maniculatus* in response to social pressure. *Comp. Biochem. Physiol.* 61A, 539–542.
- HOLST, D. V.; FUCHS, E.; STÖHR, W. (1983): Physiological changes in male *Tupaia belangeri* under different types of social stress. In: *Biobehavioral bases of coronary heart disease*. Ed. by T. M. DEMBROWSKI, T. H. SCHMIDT and G. BLÜMCHEN, Basel: Karger. 382–390.
- STÖHR, W. (1982): Telemetrische Langzeituntersuchungen der Herzfrequenz von *Tupaia belangeri*: Basalwerte sowie phasische und tonische Reaktionen auf nichtsoziale und soziale Belastungen. Diss., Bayreuth.
- WEIGOLD, M. (1979): Körpertemperatur, Sauerstoffverbrauch und Herzfrequenz bei *Tupaia belangeri* Wagner, 1841 im Tagesverlauf. *Z. Säugetierkunde* 44, 340–353.
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## Ossa interfrontalia bei einem Rehbock (*Capreolus capreolus* L.)

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An dem Schädel eines 1977 erlegten, etwa zweijährigen Rehbockes finden sich als anatomische Besonderheit zwei, zwischen die posterioren Abschnitte der Frontalia und das Parietale eingefügte, längsovale, annähernd symmetrisch ausgebildete akzessorische Knochen, die sich mit einer Länge von je 30 mm über 46 % der Ausdehnung der Interfrontalia erstrecken (Abb. 1). Diese im arttypischen Bauplan nicht auftretenden Ossa interfrontalia sind durch markante Suturen gegen die umgebenden Elemente des Schädeldaches sowie durch eine in der Mediosagittalen der Calvaria verlaufende Naht gegeneinander abgegrenzt. Das gleiche Bild ergibt sich auch bei Betrachtung der Schädellinnenseite im Fronto-Parietalbereich (Abb. 2). Hierbei fällt ferner eine Anzahl feiner Vertiefungen im Gebiet der Interfrontalknochen auf.

Die zwischen den Deckknochen des Schädeldaches auftretenden Schaltknochen lassen sich nach RANKE (1899–1900) in Naht- und Fontanelknochen einteilen. Nahtknochen